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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte DAVID B. ALLEN

Appeal 2009-003117
Application 10/733,738
Technology Center 1700

Decided: September 21, 2009

Before EDWARD C. KIMLIN, PETER F. KRATZ, and MARK NAGUMO, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

DECISION ON APPEAL

A. Introduction[1]

David B. Allen ("Allen") timely appeals under 35 U.S.C. § 134(a) from the rejection[2] of claims 2, 4-7, 9, 10, and 12-18,[3] which are all of the pending claims. We have jurisdiction under 35 U.S.C. § 6. We AFFIRM.

The subject matter on appeal relates to abrasive tip coatings for turbine blades. The 738 Specification explains that it is desirable that the gap between the blade tips and the "ring segments" be made as small as possible to limit leakage of hot gases past the blade tips. (The ring segments define, at least in part, the interior of the housing in which the turbines rotate.) Under normal running conditions, thermal expansion of the components of the turbine cause the turbine blades to make contact with the ring segments. According to the 738 Specification, a standard technique for "controlling" the blade tip clearance is to provide an abradable coating (such as a "porous thermal barrier coating," or "TBC") on the ring segments and to provide an abrasive material on the turbine blade tips. The abrasive is selected to be harder than the TBC, which acts as a sacrificial coating that is

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[1] Application 10/733,738, *Turbine Blade Tip with Optimized Abrasive*, filed 11 December 2003. The specification is referred to as the "738 Specification," and is cited as "Spec." The real party in interest is listed as Siemens Power Generation, Inc. (Appeal Brief under 37 C.F.R. § 41.37, filed 31 January 2008 ("Br."), 3.)

[2] Office Action mailed 24 September 2007 ("Rejection"). Although not a final rejection, the claims have been rejected at least twice.

[3] As Appellants note (Br. 5 n. 1), the Examiner's statements of the rejections do not reflect the claims as amended on 15 May 2006. The statements of rejection in this Opinion recite only the presently pending claims.

worn away without damaging the turbine blades while it provides an effective seal for the turbine. A conventional TBC is said to be 8 wt% yttria-stabilized zirconia ceramic ("8YSZ"). A conventional abrasive coating is said to be cubic boron nitride ("cBN").

According to the 738 Specification, a problem with the cBN abrasive coating is that "thermal decomposition of the cBN particles in an elevated temperature oxidizing environment produces effectively bare blade tips, which have been shown to have very limited cutting ability and which result in unacceptable blade tip wear." (Spec. 2, ll. 20-24.)

The 738 Specification teaches that this problem is solved by substituting a portion of the cubic boron nitride with silicon nitride (Si_3N_4). (Spec. 3, ll. 6-11.) The 738 Specification explains that, "[w]hile Si_3N_4 does not provide the equivalent cutting ability of cBN, due to Si_3N_4's lower hardness, Si_3N_4 demonstrates greater resistance to thermal degradation in the high temperature, oxidizing environment of the turbine engine." (*Id.* at 5, ll. 19-22.)

In another embodiment, the 738 Specification teaches that "[t]he abrasives can be placed, . . . and be included in a super alloy matrix that is preferably nickel and/or cobalt-based. The super alloy can be CoNiCrAlY and may have other added elements for enhanced oxidation life." (Spec. 3, ll. 13-16.) The 738 Specification explains that "Si_3N_4 also exhibits excellent resistance to reaction with cobalt and nickel commonly found in the super alloy metal matrix used to bond the cBN to the blade tip." (*Id.* at ll. 22-24.)

Representative Claim 2 and 4 are reproduced from the Claims Appendix to the Principal Brief on Appeal:

2. A turbine blade with abrasive tip coating, comprising:
an elongated turbine blade having a tip at one end,
said tip having an abrasive coating including
a substantially 50:50 mixture of cubic boron nitride and silicon nitride.

(Claims App., Br. 18; indentation and paragraphing added.)

4. A turbine blade with abrasive tip coating, comprising:
an elongated turbine blade having a tip at one end,
said tip having an abrasive coating including
a mixture of cubic boron nitride, silicon nitride and CoNiCrAlY.

(Claims App., Br. 18; indentation and paragraphing added.)

The Examiner has maintained the following grounds of rejection:[4]

A. Claims 2 and 6 stand rejected under 35 U.S.C. § 103(a) in view of the teachings of Schaefer.[5]

B. Claims 4, 5, 7, 9, 10, and 12-18 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of Schaefer and Freling.[6]

C. Claims 4, 5, 7, 9, 12-15, and 18 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of Schaefer and Ohara.[7]

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[4] Examiner's Answer mailed 29 April 2008. ("Ans.").

[5] Robert P. Schaefer et al., *Abrasive Material, Especially for Turbine Blade Tips*, U.S. Patent 4,735,656 (1988).

[6] Melvin Freling et al., *Columnar Zirconium Oxide Abrasive Coating for a Gas Turbine Engine Seal System*, U.S. Patent 6,190,124 B1 (2001).

Allen contends that the Examiner erred by reading too much into Schaefer's disclosure that various ceramics, including boron nitride, are known as abrasives, and that the ceramics may be mixed. (Br. 10.) Allen points out that Schaefer does not "specifically call out the claimed combination of cubic boron nitride and silicon nitride," and that Schaefer does not teach the relative amounts of such materials. (*Id.*) Moreover, Allen argues that the claimed invention goes against conventional thinking by decreasing the amount of the hard cBN in favor of the softer silicon nitride. (*Id.* at 11.) Allen also urges that it was surprising that the initial cutting ability of the 50:50 cBN:SiN mixture was "comparable" to that of 100 % cBN. (*Id.*, citing Spec. 6, ll. 15-18.) As further evidence of unexpected results, Allen cites the retention of the benefits of each component in the 50:50 mixture, namely, the superior cutting properties of cBN and the greater resistance to thermal degradation of the silicon nitride. (*Id.* at 11-12, citing Spec. 5, ll. 26-29.)

Regarding the remaining rejections, Allen argues that the Examiner's reliance on Freling and on Ohara fail to cure the deficiencies of Schaefer. Thus, the remaining arguments are merely cumulative with the arguments with respect to Schaefer.

The dispositive issues are whether Allen has shown reversible error in the Examiner's findings as to the teachings of Schaefer; or whether Allen has shown unexpected results that rebut a prima facie case of obviousness.

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[7] Minoru Ohara and Masahiko Mega, *Combustion Engine, Gas Turbine, and Polishing Layer*, U.S. Patent 6,896,845 B2 (2005), based on an application having an effective filing date of 29 April 2003.

B. Findings of Fact

Findings of fact throughout this Opinion are supported by a preponderance of the evidence of record.

1. According to the 738 Specification, "approximately equal amounts of cBN and Si_3N_4 were applied to subscale turbine blade tips via electroplating and were tested against a porous 8YSZ coating to measure cutting ability." (Spec. 6, ll. 11-13.)

2. The 738 Specification states that the tips were also exposed to simulated turbine gas path environment for various times to determine their resistance to thermal degradation. (Spec. 6, ll. 13-15.)

3. In the words of the 738 Specification, "Surprisingly, the initial (non-thermally degraded) cutting capability of the mixed abrasive tip was shown to be comparable to a tip with 100% cBN, demonstrating that the blade's initial cutting capability is not substantially sacrificed by replacing some of the cBN abrasive particles with Si_3N_4." (Spec. 6, ll. 15-18.)

4. The 738 Specification reports further that

> [a]n identical blade was exposed to a 1000°C oxidizing environment similar to that experienced by an actual turbine engine blade, for a period of 200 hours. This blade was tested against a sintered (thermally exposed) porous 8YSZ coating and its cutting ability, while much reduced versus the fresh blade, was superior to that of a similarly exposed blade with tip comprised solely of cBN.

(Spec. 6, ll. 18-23.)

5. The 738 Specification contains no other data or descriptions of these or similar tests.

6. Schaefer teaches abrasive ceramic-based coatings for turbine blades.

7. In most relevant part, Schaefer teaches:

> Various ceramics may be used, so long as good metal-ceramic adhesion is achieved. For the abrasive materials which are the prime object of the present invention, it is necessary that the ceramic not interact with the metal matrix because this degrades the wear resistance of the ceramic and thus the entirety of the material. Ceramics which are not inherently chemically resistant must be coated as is the silicon carbide. *Other essential materials* which may or may not be coated with another ceramic and *which are within contemplation for high temperature applications include silicon nitrides and the various alloys of such*, particularly silicon-aluminum oxynitride, often referred to as SiAlON. *Boron nitride is a material that some have favored. Of course, it is feasible to mix such materials.* At lower temperatures, virtually any ceramic material may be used, depending on the intended use of the ceramic-metal composite."

(Schaefer col. 6, l. 54, to col. 7, l. 2 (emphasis added); quoted (without added emphasis) at Br. 10.)

8. Freling teaches "tip caps" for turbine blades comprising a superalloy boat comprising an abrasive grit, such as silicon carbide or silicon nitride. (Freling, col. 1, l. 64, to col. 2, l. 5.)

9. In another embodiment, Freling teaches that electroplated cBN superalloy blade tips may be prepared. (Freling, col. 2, l. 31-35.)

10. According to Freling, cBN tips "are excellent cutters because cBN is harder than any other grit material except diamond." (Freling, col. 2, ll. 35-37.)

11. Freling also teaches that "the higher temperatures in the turbine section can cause the cBN grits and perhaps even the metal matrix to oxidize." (Freling, col. 2, ll. 40-43.)

12. Ohara teaches abrasive layers on turbine blade tips. (Ohara, col. 1, ll. 5-12.)

13. According to Ohara, "since the cubic boron nitride has insufficient heat resistance, it is turned into boron oxide and sublimated by a long-term operation in an oxidizing atmosphere, so that the abrasive particle sometimes disappear." (Ohara, col. 1, l. 65, to col. 2, l. 1.)

14. Moreover, Ohara teaches that "the abrasive particles sometimes fall off gradually as MCrAlY is deteriorated at oxidation." (Ohara, col. 2, ll. 1-3.)

15. Ohara teaches further that these problems are exacerbated by the higher temperatures associated with more energy efficient in gas turbines. (Ohara, col. 2, ll. 7-13.)

C. Discussion

As the Appellant, Allen bears the procedural burden of showing harmful error in the Examiner's rejections. *See, e.g., In re Kahn*, 441 F.3d 977, 985-86 (Fed. Cir. 2006) ("On appeal to the Board, an applicant can overcome a rejection [under § 103] by showing insufficient evidence of *prima facie* obviousness") (citation and internal quote omitted).

Allen's criticism that Schaefer does not "call out" the particular combination of cBN and Si_3N_4 or the 50:50 ratio, while accurate, does not

demonstrate that the Examiner erred in concluding that turbine blades covered by claims 2 and 6 would have been obvious. Allen does not dispute that Schaefer "calls out" boron nitride and silicon nitride, among other ceramics. Nor does Allen dispute that Schaefer teaches that combinations of ceramics may be used. Moreover, Allen does not dispute that Schaefer provides some guidance as to what properties various combined ceramics and metals matrices should have, e.g., inertness of the ceramic to the metal matrix. (Schaefer, col. 6, l. 54-61.) Notably, Allen does not indicate that those skilled in the art would have thought that cBN and Si_3N_4 would be incompatible with any of the conditions cited by Schaefer. Moreover, Schaefer's teaching that various ceramics can be combined to form various abrasive materials indicates that hardness or cutting ability are not the only considerations for the selection of abrasive ceramics. We also note that both Freling (col. 1, l. 64, to col. 2, l. 5) and Ohara (col. 1, l. 65, to col. 2, l. 13) show that the thermal deficiencies of cBN as an abrasive ceramic in turbine blade tips were known in the art of turbine blade manufacturing. Compared to the evidence of record, Allen's argument that reducing the amount of hard cBN has gone against "conventional thinking" (Br. 11) is unsupported, and thus entitled to no significant weight.

On the present record, it appears that the combination of elements, including adjusting the relative amounts, would have been, to paraphrase the words of the Supreme Court, likely to be obvious *if* it does no more than yield predictable results. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 416 (2007). Allen does not dispute that the combination of ceramics or the formation of the abrasive coating on the turbine blades would have been

within the ability of the person of ordinary skill to implement. Accordingly, we turn to Allen's arguments for unexpected results.

At first glance, Allen's argument that a 50:50 cBn:Si_3N_4 abrasive mixture having a cutting ability comparable to 100% cBN would have been unexpected is attractive. However, the 738 Specification does not provide any more detailed descriptions of the tests and the conditions of the tests than are provided *supra*. The reader thus has no basis to evaluate the basis for the conclusion that the cutting ability was "comparable"; nor does the reader have any basis to determine whether the characterization "comparable" is reasonable. The reported superiority of the cutting characteristics following heat treatment of a turbine blade coated with a 50:50 cBN:Si_3N_4 mixture is subject to similar criticisms. As our reviewing court has explained on several occasions, "[i]t is well settled that unexpected results must be established by factual evidence. Mere argument or conclusory statements in the specification does not suffice." *In re Soni*, 54 F.3d 746, 750 (Fed. Cir. 1995), quoting *In re De Blauwe*, 736 F.2d 699, 705 (Fed. Cir. 1984).

We conclude that Allen has failed to support its arguments for unexpected results rebutting the prima facie case of obviousness of turbine blades covered by claims 2 and 6 with credible factual evidence.

Although Allen provides arguments under separate headings for the distinct patentability of claims 4 and 18, claim 5, and claims 7, 9, 19, and 12-16 or 12-17 with respect to the rejections over the combined teachings of Schaefer and either Freling or Ohara, the arguments are substantively cumulative with the objections to the teachings of Schaefer. Thus, while

Allen criticizes the alleged failure of a teaching of the combination of cBN, Si_3N_4, and CoNiCrAlY super alloy in any of the references (Br. 13-16), Allen does not explain, for example, why the Examiner erred in holding that turbine blade tips comprising the *combination* of the mixed abrasive with the super alloy would have been obvious. Thus, Allen has done no more than to attack the teachings of the individual references. However, it is well established that "[n]on-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references." *In re Merck*, 800 F.2d 1091, 1097 (Fed. Cir. 1986) (citation omitted.) As for the allegedly unexpected results reported in the 738 Specification, not only are the showings deficient for lack of data, as discussed *supra*, but is there no credible evidence that the coatings were within the scope of claim 4, i.e., that the abrasive coatings comprised the CoNiCrAlY super alloy. Moreover, the single cBN:Si_3N_4 ratio is not commensurate in scope with the range of cBN:Si_3N_4 ratios covered by claim 4 and claims dependent on claim 4.

D. Order

We AFFIRM the rejection of claims 2 and 6 under 35 U.S.C. § 103(a) in view of the teachings of Schaefer.

We AFFIRM the rejection of claims 4, 5, 7, 9, 10, and 12-18 under 35 U.S.C. § 103(a) in view of the combined teachings of Schaefer and Freling.

We AFFIRM the rejection of claims 4, 5, 7, 9, 12-15, and 18 under 35 U.S.C. § 103(a) in view of the combined teachings of Schaefer and Ohara.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

kmm

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